

FORM PTO-1346
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER

MAF0002.US

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

10/031729

INTERNATIONAL APPLICATION NO.
PCT/IB00/01140INTERNATIONAL FILING DATE
19 July 2000PRIORITY DATE CLAIMED
22 July 1999

TITLE OF INVENTION

TRANSITION FROM A WAVEGUIDE TO A MICROSTRIP

APPLICANT(S) FOR DO/EO/US

Sigmund Lenz, et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☒ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:
PCT/RO/101 - English
PCT/ISA/210 - English

U.S. APPLICATION NO. (if known, see 37 CFR 1.51) 10/031729		INTERNATIONAL APPLICATION NO. PCT/IB00/01140		ATTORNEY'S DOCKET NUMBER MAF0002.US																																																																									
21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. \$1000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY																																																																									
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<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:20%;">CLAIMS</th> <th style="width:20%;">NUMBER FILED</th> <th style="width:20%;">NUMBER EXTRA</th> <th style="width:20%;">RATE</th> <th style="width:20%;">\$</th> <th style="width:20%;"></th> </tr> </thead> <tbody> <tr> <td>Total claims</td> <td>7 - 20 =</td> <td>0</td> <td>x \$18.00</td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td>Independent claims</td> <td>1 - 3 =</td> <td>0</td> <td>x \$80.00</td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable)</td> <td>- \$270.00</td> <td>\$ 0.00</td> </tr> <tr> <td colspan="4" style="text-align: center;">TOTAL OF ABOVE CALCULATIONS =</td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4"> <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. </td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4" style="text-align: center;">SUBTOTAL =</td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4"> Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)). </td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4" style="text-align: center;">TOTAL NATIONAL FEE =</td> <td>\$1,020.00</td> <td></td> </tr> <tr> <td colspan="4"> Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property + </td> <td>\$ 0.00</td> <td></td> </tr> <tr> <td colspan="4" style="text-align: center;">TOTAL FEES ENCLOSED =</td> <td>\$1,020.00</td> <td></td> </tr> <tr> <td colspan="4" rowspan="2"></td> <td style="text-align: center;">Amount to be refunded:</td> <td style="text-align: center;">\$</td> </tr> <tr> <td style="text-align: center;">charged:</td> <td style="text-align: center;">\$</td> </tr> </tbody></table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$		Total claims	7 - 20 =	0	x \$18.00	\$ 0.00		Independent claims	1 - 3 =	0	x \$80.00	\$ 0.00		MULTIPLE DEPENDENT CLAIM(S) (if applicable)				- \$270.00	\$ 0.00	TOTAL OF ABOVE CALCULATIONS =				\$ 0.00		<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$ 0.00		SUBTOTAL =				\$ 0.00		Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0.00		TOTAL NATIONAL FEE =				\$1,020.00		Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 0.00		TOTAL FEES ENCLOSED =				\$1,020.00						Amount to be refunded:	\$	charged:	\$
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- a. ☒ A check in the amount of \$ 1,020.00 to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
overpayment to Deposit Account No. 20-0095. A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card
information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Todd T. Taylor, TAYLOR & AUST, P.C.
P.O. Box 560
142 South Main St.
Avilla, IN 46710

SIGNATURE

Todd T. Taylor

NAME

36,945

REGISTRATION NUMBER

THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of)
Sigmund Lenz, et al.) Group:
Serial No.:)
Filed: January 21, 2002)
PCT No.: PCT/IB00/01140)
Int. Filing Date: July 19, 2000) Examiner:
Priority Date: July 22, 1999)
Title: TRANSITION FROM A WAVEGUIDE)
TO A MICROSTRIP)

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Please enter the following Amendment to the application prior to calculating the filing fee.

Attached hereto as "ATTACHMENT A" is a marked-up copy showing the changes made to the above-identified patent application by the present Amendment.

IN THE SPECIFICATION

Please replace the current specification with the substitute specification attached hereto.

IN THE ABSTRACT

Please delete the abstract in its entirety and replace therefor the abstract attached hereto.

IN THE CLAIMS

Please cancel claims 1-7.

Please add the following new claims 8-14:

8. (New) A transition from a waveguide to a microstrip, comprising:

a substrate including a plurality of ground surfaces superimposed on one another, the

microstrip extending on said substrate; and

a plurality of through-contacts providing electrical connectivity to said plurality of ground

5 surfaces;

wherein the waveguide includes a waveguide wall with an opening therein, said substrate projecting through said opening into the waveguide such that at least a portion of the microstrip is disposed within the waveguide, at least one of said plurality of ground surfaces being in contact with said waveguide wall.

9. (New) The transition of claim 8, further comprising a through-plating in said substrate at an end of the microstrip, said through-plating disposed within the waveguide; wherein said end of the microstrip acts as an antenna.

10. (New) The transition of claim 8, wherein said plurality of ground surfaces include a first ground surface and a second ground surface, said first ground surface being superimposed on a surface of said substrate adjacent to a side of the microstrip and said second ground surface being superimposed on a surface of said substrate adjacent to an other side of the microstrip, said
5 first and second ground surfaces being in contact with other of said plurality of ground surfaces via at least one of said plurality of through-contacts.

11. (New) The transition of claim 8, further comprising:

at least one screw; and

a support disposed proximate said waveguide wall, said substrate being fixedly connected to said support by said at least one screw;

5 wherein said at least one screw extends through said plurality of ground surfaces making electrical contact between said ground surfaces and said support.

12. (New) The transition of claim 11, further comprising a conductive ribbon, wherein said at least one screw lies with its head on one of said plurality of ground surfaces applied to an

upper side of said substrate adjacent the microstrip, said conductive ribbon connected to said waveguide wall and clamped between said head of said at least one screw and one of said plurality
 5 of ground surfaces.

13. (New) The transition of claim 10, further comprising:

a projection of said waveguide wall; and

at least one conductive elastic body being inserted between said projection and at least one of said first ground surface and said second ground surface.

14. (New) The transition of claim 11, further comprising:

a projection of said waveguide wall; and

at least one conductive elastic body being inserted between said projection and said at least one screw.

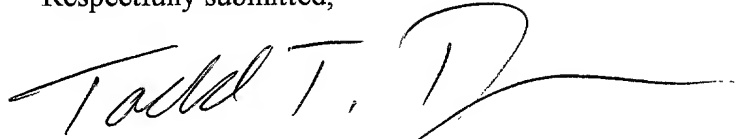
REMARKS

In compliance with MPEP § 608.01(q), Applicants submit that no new matter has been added in the substitute specification attached hereto. Applicants have included a marked-up copy of the original specification, the changes indicated therein corresponding to the changes implemented in the substitute specification.

In the event Applicants have overlooked the need for an extension of time, an additional extension of time, payment of fee, or additional payment of fee, Applicants hereby conditionally petition therefor and authorize that any charges be made to Deposit Account No. 20-0095, TAYLOR & AUST, P.C.

Should any question concerning any of the foregoing arise, the Examiner is invited to telephone the undersigned at (219) 897-3400.

Respectfully submitted,



Todd T. Taylor
Registration No. 36,945

Attorney for Applicant

TTT6/tj

TAYLOR & AUST, P.C.
142 S. Main Street
P.O. Box 560
Avilla, IN 46710
Telephone: 219-897-3400
Facsimile: 219-897-9300

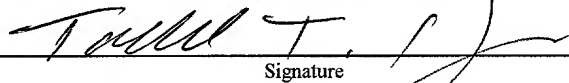
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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to:
Commissioner for Patents, Washington, DC 20231, on: January 22, 2002.

Todd T. Taylor, Reg. No. 36,945

Name of Registered Representative



Signature

January 22, 2002
Date

Title: TRANSITION FROM A WAVEGUIDE TO A MICROSTRIP

Application Serial No.:

Group:

Examiner:

ATTACHMENT A:
MARKED-UP COPY SHOWING AMENDMENTS

IN THE SPECIFICATION

Attached herewith is a marked-up copy of the specification.

IN THE CLAIMS

Please cancel claims 1-7.

Please add the following new claims 8-14:

8. (New) A transition from a waveguide to a microstrip, comprising:
- a substrate including a plurality of ground surfaces superimposed on one another, the microstrip extending on said substrate; and
- a plurality of through-contacts providing electrical connectivity to said plurality of ground surfaces;
- wherein the waveguide includes a waveguide wall with an opening therein, said substrate projecting through said opening into the waveguide such that at least a portion of the microstrip is disposed within the waveguide, at least one of said plurality of ground surfaces being in contact with said waveguide wall.
9. (New) The transition of claim 8, further comprising a through-plating in said substrate at an end of the microstrip, said through-plating disposed within the waveguide; wherein said end of the microstrip acts as an antenna.
10. (New) The transition of claim 8, wherein said plurality of ground surfaces include a first ground surface and a second ground surface, said first ground surface being superimposed on a surface of said substrate adjacent to a side of the microstrip and said second ground surface
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Title: TRANSITION FROM A WAVEGUIDE TO A MICROSTRIP

Application Serial No.:

Group:

Examiner:

being superimposed on a surface of said substrate adjacent to an other side of the microstrip, said first and second ground surfaces being in contact with other of said plurality of ground surfaces via at least one of said plurality of through-contacts.

11. (New) The transition of claim 8, further comprising:

at least one screw; and

a support disposed proximate said waveguide wall, said substrate being fixedly connected to said support by said at least one screw;

wherein said at least one screw extends through said plurality of ground surfaces making electrical contact between said ground surfaces and said support.

12. (New) The transition of claim 11, further comprising a conductive ribbon, wherein said at least one screw lies with its head on one of said plurality of ground surfaces applied to an upper side of said substrate adjacent the microstrip, said conductive ribbon connected to said waveguide wall and clamped between said head of said at least one screw and one of said plurality of ground surfaces.

13. (New) The transition of claim 10, further comprising:

a projection of said waveguide wall; and

at least one conductive elastic body being inserted between said projection and at least one of said first ground surface and said second ground surface.

14. (New) The transition of claim 11, further comprising:

a projection of said waveguide wall; and

at least one conductive elastic body being inserted between said projection and said at least one screw.

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5 Transition from a waveguide to a microstrip~~State of the Art~~1. field of invention

The ~~present~~ invention relates to a transition from a waveguide to a
 10 microstrip, ^{and more particularly, to a} wherein ~~the~~ microstrip extending on a substrate projects ⁱⁿ through an opening into ~~the~~ waveguide and a ground line associated ~~with~~ ^{herewith,} the microstrip contacts the waveguide wall.

2. Description of the related art

~~Such~~ A transition from a waveguide to a microstrip is known from US
 15 5,202,648. ^{Wherein, a} ~~In this connection,~~ ^{is} ~~the~~ microstrip ^{is} extends ^{on} ~~the~~ upper side of ^{an} the substrate and ~~the~~ ^{an} associated ground line, ^{side of the} consists of a conductive surface on ~~the~~ ^{an} opposite ^{side of the} substrate ~~side~~ which contacts the waveguide wall.

^{problem is that} One weak point of transitions between a waveguide and a contact strip
 20 designed in this way ^{has} ~~is~~ a reflection attenuation ^{that} ~~which~~ is frequently too low and also a transmission attenuation which is too high.

What is needed is . . .

It is the underlying object of the invention to provide a transition, of the
 kind first mentioned which has the highest possible reflection attenuation
 and the lowest possible transmission attenuation.

25

Advantages of the InventionSummary of the Invention

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^A
~~In accordance with claim 1, the ground line associated with the~~ ^a ~~microstrip includes~~
~~consists of~~ a plurality of ground surfaces superimposed on one another all of
 which ~~all~~ ^{way} contact one another by ~~means~~ of through-contacts in ~~the~~ a
 substrate. The multi-layer ground line produces a more favorable field
 5 conversion from the microstrip to the waveguide, ~~thereby~~ ^{thus} a high reflection
 attenuation and a low transmission attenuation ~~arises for the transition.~~
^{Results}

~~Advantageous further developments of the invention can be seen from the~~
~~dependent claims.~~

10

~~Since~~ ^{which acts} a throughplating is provided in the substrate at the end of the
 microstrip ~~acting~~ ^{which} as an antenna and ~~projecting~~ ^s into the waveguide, ^{thus} the
 transition bandwidth ~~becomes larger.~~ ^{is enlarged.}

15 To ~~be able to~~ make a good contact between the ^{multi-layer} ground line and the
 waveguide wall, it is expedient for ground surfaces to be applied to the
 substrate ^{on} ~~at~~ ^{thereof,} both sides, next to the microstrip and for these ground
 surfaces to be in contact with the ~~other~~ ^{that are} ground surfaces superimposed on
 one another in the substrate via through contacts (vias). Advantageously,
 20 the substrate is fixed ^{by} at least one screw ^{on} a support ^{on} the waveguide
 wall, ~~with~~ ^{is} the screw being guided through the ground surface ~~and~~ ^{to the support}
 electrical contact ~~being~~ ^{is} made between these ^{ground surfaces} and the support.

A low transmission attenuation is achieved ^{by way of} ~~in that~~ the at least one screw having
 25 ~~lies with~~ its head on one of the ground surfaces ^{which is} applied to the upper side of the
 substrate, ~~side at the side~~ ^{by way of} next to the microstrip and ~~in that~~ ^{the} a conductive
 ribbon, ~~which~~ ^{that} is connected to the waveguide wall, ^{the conductive ribbon being} is clamped between the
 screw head and the ground surface. Alternatively, ~~to this,~~ at least one

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conductive elastic body ^{is} ~~can~~ be inserted between one of the two ground surfaces located to ^{each} ~~the~~ side of the microstrip and a projection of the waveguide wall projecting over the ground surfaces. ^{Further} ~~Moreover~~ a conductive elastic body can be pressed ~~is~~ between the head of the at least one screw and the projection of the waveguide wall.

Drawing

10 The invention will be described in more detail in the following with reference to a plurality of embodiments shown in the drawing. There are shown:

Figure 1 a perspective illustration of a transition from a waveguide to a microstrip;
 Figure 2 a longitudinal section A-A through the transition; and
 Figure 3 a cross-section B-B through the transition.

20 ~~Description of embodiments~~

Detailed Description of the Invention

Referring now to the drawings, and more particularly to

As can be seen from the perspective schematic diagram in Figure 1, ~~a~~ there is illustrated a microstrip 2 ~~extends~~ on a multi-layer substrate 1. ~~An~~ Opening 4 is located in a side wall of ~~a~~ waveguide 3 and ~~a~~ tongue 5, ^{of} ~~located at the~~ substrate 1, projects through it into the waveguide 3. The ^{Portion} ~~end~~ of the waveguide 2 which ^{Microstrip} ~~extending on the~~ tongue 5 ^{is} ~~acts as~~ antenna 6 for coupling the which couples a waveguide field to the microstrip and/or vice versa.

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Now, Additionally referring to

there is shown

~~As shown in more detail in Figures 2 and 3~~ two ground surfaces 7 and 8, which are applied to the upper ^{side of} substrate ¹ side next to the microstrip 2, and, in addition, a plurality of ground surfaces ⁹ are superimposed on one another within the multi-layer substrate ¹ and ^{each} ^{ing} have the same ground potential.

- 5 ~~The~~ Cross-section B-B, through the waveguide 3 into the substrate 1, shown in Figure 3 shows the multi-layer ground surfaces 9 within the substrate 1.

- 10 ~~The~~ longitudinal section A-A, shown in Figure 2 shows ~~the~~ two symmetrical ground surfaces 7 and 8, ^{respectively along each} at both sides of the microstrip 2. These ground surfaces 7 and 8, on the upper ^{side of} substrate ¹ side are connected in an electrically conductive manner by a plurality of through-contacts 10 to ~~the~~ other ground surfaces ^{which are} 9 superimposed on one another within the substrate 1. The positions and spacings of ~~the~~ through-contacts 10 are
- 15 selected such that a field propagation into the intermediate areas between the ground surfaces of the multi-layer substrate ¹ is prevented, since the function of circuits, arranged in ~~the~~ individual substrate layers, ^{could} ~~are~~ thereby be interfered with.

- 20 ~~The~~ ground surfaces 9 of the substrate 1, preferably project some tenths of a millimeter into the waveguide 3, ^{thereby} ~~in order to~~ increase ^{ing} the positional tolerance of the substrate 1 with respect to the waveguide 3. The field configuration beneath the microstrip 2 in the waveguide 3 closely depends on the position of the ground surfaces 9. If the position of the substrate 1
- 25 is ~~now~~ slightly changed, ~~then~~ the field remains unchanged due to the positional tolerance of the ground surfaces 9. At an operational frequency of, for example, 10 GHz, a penetration depth of the ground surfaces 9 into the waveguide 3 of 0.5 - 1.0 mm is appropriate.

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~~The~~¹¹ multi-layer substrate 1 forms a larger virtual ground, whereby a field configuration arises which is better transformed into a waveguide wave. The field is ~~namely~~ shaped more intensely into a field component of the fundamental wave type of ~~the~~ waveguide³ by the larger expansion of the ground (due to the many ground surfaces⁹ stacked on top of one another) in the direction of the broad side of ~~the~~ waveguide 3.

It can be seen from Figures 2 and 3 that a through¹¹plating 11 is provided at the end of ~~the~~ antenna 6 of ~~the~~ microstrip 2 extending on ~~the~~ substrate tongue 5. This ~~Through~~¹¹plating 11 at the end of ~~the~~ antenna 6 of ~~the~~ microstrip² results in a broadening of the frequency band of the transition from ~~the~~ waveguide 3 to ~~the~~ microstrip 2. The ~~Through~~¹¹plating¹¹ at the end of ~~the~~ antenna 6, ~~also becomes~~¹⁵ larger due to the thicker design of ~~the~~ substrate 1, which contributes to a more favorable conversion of the microstrip field into the waveguide field.

~~The~~⁴ Substrate 1 is fixed to a ~~Support~~¹⁴ 14 beneath ~~the~~ Opening¹⁴ 14 and ~~starting from the waveguide wall by means of at least one screw,~~ there being ~~are~~ two screws 12 and 13 in the embodiment shown in Figure 2. In this connection, the ~~Screws~~ 12 and 13 lie with their heads on the ground surfaces 7 and 8 applied ~~to the side next to the~~ microstrip 2 and ~~thus~~ screws^{12 and 13} make an electrical contact between ~~the~~ ground surfaces 7 and 8 and ~~the~~ ground surfaces 9 superimposed on one another in ~~the~~ substrate 1 and the waveguide wall¹⁴ 14. Since ~~a~~^{electrical} contact is additionally made between ~~the~~ ground lines 7 and 8, applied to the upper side of ~~the~~ substrate 1, and ~~the~~ waveguide wall¹⁴ 14, the transmission attenuation of the transition is reduced. This contact can, as shown in Figure 2, be made by two conductive

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ribbons 15 and 16, which are clamped at one end between the heads of the screws 12 and 13 and the conductive surfaces 7 and 8 and at their other end in the parting plane 17 of the waveguide 3, ^{including} ~~consisting of~~ two half shells.

5

effecting

and

Figure 3 shows another variant for ^{effecting} ~~the~~ contact of ^{and} ~~the~~ ground surfaces 7 and 8; and screws 12 ^{and} 13, with ^{electrical} ~~the~~ waveguide wall. Here, the waveguide 3 has a wall projection 18 above ^{it} ~~the~~ opening 4 which projects over the ground surfaces 7 and 8 on the upper side of the substrate 1. One or more

10 conductive elastic bodies 19 are clamped between the ground surfaces 7 and 8 on the upper ^{side of} ~~substrate~~ ¹ ~~side~~ and the wall projection 18. One or more conductive elastic bodies 20 can also be pressed between the heads of the screws 12 and 13 and the wall projection 18.

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TRANSITION FROM A WAVEGUIDE TO A MICROSTRIP**BACKGROUND OF THE INVENTION****1. Field of the invention.**

5 The invention relates to a transition from a waveguide to a microstrip, and more particularly, to a microstrip extending, on a substrate, projecting through an opening into a waveguide and a ground line associated therewith.

2. Description of the related art.

 A transition from a waveguide to a microstrip is known from U.S. 5,202,648. Wherein, a
10 microstrip is extended on an upper side of a substrate and an associated ground line, consisting of a conductive surface on an opposite side of the substrate, contacts the waveguide wall. A problem is that a waveguide and a contact strip designed in this way has a reflection attenuation that is frequently too low and a transmission attenuation which is too high.

 What is needed in the art is a transition, which has the highest possible reflection
15 attenuation and the lowest possible transmission attenuation.

SUMMARY OF THE INVENTION

 A ground line associated with a microstrip includes a plurality of ground surfaces
superimposed on one another all of which contact one another by way of through-contacts in a
substrate. The multi-layer ground line produces a more favorable field conversion from the
20 microstrip to the waveguide, thereby a high reflection attenuation and a low transmission
attenuation results.

 A through-plating is provided in the substrate at the end of the microstrip which acts as
an antenna and which projects into the waveguide, thus transition bandwidth is enlarged.

 To make a good contact between the multi-layer ground line and the waveguide wall, it is
25 expedient for ground surfaces to be applied to the substrate on both sides thereof, next to the

microstrip and for these ground surfaces to be in contact with the ground surfaces, that are superimposed on one another in the substrate via through-contacts (vias). Advantageously, the substrate is fixed, by at least one screw, on a support, on the waveguide wall. The screw is guided through the ground surfaces to the support and electrical contact is made between the ground surfaces and the support.

A low transmission attenuation is achieved by way of the at least one screw having its head on one of the ground surfaces, which is applied to the upper side of the substrate, next to the microstrip and by way of a conductive ribbon that is connected to the waveguide wall, the conductive ribbon being clamped between the screw head and the ground surface. Alternatively, at least one conductive elastic body is inserted between one of the two ground surfaces located to each side of the microstrip and a projection of the waveguide wall projecting over the ground surfaces. Further, a conductive elastic body can be pressed between the head of the at least one screw and the projection of the waveguide wall.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a perspective illustration of a transition from a waveguide to a microstrip;

Fig. 2 is a longitudinal section A-A through the transition; and

Fig. 3 is a cross-section B-B through the transition.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention,

in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly to Fig. 1, there is illustrated a
5 microstrip 2 on a multi-layer substrate 1. Opening 4 is located in a side wall of waveguide 3 and tongue 5, of substrate 1, projects into waveguide 3. The portion of microstrip 2 which extends on tongue 5 is antenna 6 which couples a waveguide field to microstrip 2 and/or vice versa.

Now, additionally referring to Figs. 2 and 3 there is shown two ground surfaces 7 and 8,
which are applied to the upper side of substrate 1 next to microstrip 2. A plurality of ground
10 surfaces 9 are superimposed on one another within multi-layer substrate 1 each having the same ground potential. Cross-section B-B, through waveguide 3 into substrate 1, shown in Fig. 3 shows multi-layer ground surfaces 9 within substrate 1.

Longitudinal section A-A, shown in Fig. 2, shows two symmetrical ground surfaces 7 and 8, respectively, along each side of microstrip 2. Ground surfaces 7 and 8, on the upper side of
15 substrate 1, are connected in an electrically conductive manner by a plurality of through-contacts 10 to other ground surfaces 9, which are superimposed on one another within substrate 1. The position and spacing of through-contacts 10 are selected such that a field propagation, into the intermediate areas between the ground surfaces of multi-layer substrate 1, is prevented since the function of circuits arranged in individual substrate layers, are thereby interfered with.

20 Ground surfaces 9 of substrate 1, preferably project some tenths of a millimeter into waveguide 3, thereby increasing the positional tolerance of substrate 1 with respect to waveguide 3. The field configuration beneath microstrip 2 in waveguide 3 closely depends on the position of ground surfaces 9. If the position of substrate 1 is slightly changed the field remains unchanged due to the positional tolerance of ground surfaces 9. At an operational frequency of,

for example, 10 GHz, a penetration depth of ground surfaces 9 into waveguide 3 of 0.5 - 1.0 mm is appropriate.

Multi-layer substrate 1 forms a large virtual ground, whereby a field configuration arises which is better transformed into a waveguide wave. The field is shaped more intensely into a field component of the fundamental wave type of waveguide 3 by the larger expansion of the ground (due to the many ground surfaces 9 stacked on top of one another) in the direction of the broad side of waveguide 3.

It can be seen from Figs. 2 and 3 that a through-plating 11 is provided at the end of antenna 6 of microstrip 2 extending on substrate tongue 5. Through-plating 11 at the end of antenna 6 of microstrip 2 results in a broadening of the frequency band of the transition from waveguide 3 to microstrip 2. Through-plating 11, at the end of antenna 6, is large due to the thicker design of substrate 1, which contributes to a more favorable conversion of the microstrip field into the waveguide field.

Substrate 1 is fixed to support 14 beneath opening 4 by at least one screw; there being two screws 12 and 13 in the embodiment shown in Fig. 2. Screws 12 and 13 lie with their heads on ground surfaces 7 and 8 next to microstrip 2 and screws 12 and 13 make an electrical contact between ground surfaces 7 and 8 and ground surfaces 9 superimposed on one another in substrate 1 and waveguide wall 14. Since electrical contact is additionally made between ground lines 7 and 8, applied to the upper side of substrate 1, and waveguide wall 14, the transmission attenuation of the transition is reduced. This contact can, as shown in Fig. 2, be made by two conductive ribbons 15 and 16, which are clamped at one end between the heads of screws 12 and 13 and conductive surfaces 7 and 8 and at their other end in parting plane 17 of waveguide 3, including two half shells.

Fig. 3 shows another variant for effecting the electrical contact of ground surfaces 7 and 8, and screws 12 and 13, with waveguide wall 14. Waveguide 3 has a wall projection 18 above opening 4 which projects over ground surfaces 7 and 8 on the upper side of substrate 1. One or more conductive elastic bodies 19 are clamped between ground surfaces 7 and 8 on the upper
5 side of substrate 1 and wall projection 18. One or more conductive elastic bodies 20 can also be pressed between the heads of screws 12 and 13 and wall projection 18.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its
10 general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

ABSTRACT OF THE DISCLOSURE

A transition from a waveguide to a microstrip, including a substrate having a plurality of ground surfaces superimposed on one another, the microstrip extending on the substrate and a plurality of through-contacts providing electrical connectivity to the plurality of ground surfaces.

- 5 Wherein the waveguide includes a waveguide wall with an opening therein, the substrate projecting through the opening into the waveguide such that at least a portion of the microstrip is disposed within the waveguide, at least one of the plurality of ground surfaces being in contact with the waveguide wall.

JG13 Rec'd PCT/PTO 22 JAN 2002

[illegible]

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DECLARATION

I, Jeffrey C. Barfield, of Ahornstrasse 17, 82377 Penzberg, Germany, do hereby declare that I am conversant with the English and German languages and that I am a competent translator thereof.

I verify that the attached English translation is a true and correct translation of the PCT patent application with the international file reference

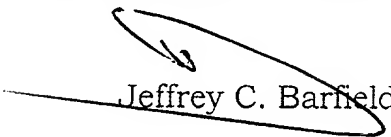
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and the international publication number

WO 01/08252 A1.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: January 16, 2002


Jeffrey C. Barfield

5 Transition from a waveguide to a microstrip

State of the Art

10 The present invention relates to a transition from a waveguide to a microstrip, wherein the microstrip extending on a substrate projects through an opening into the waveguide and a ground line associated with the microstrip contacts the waveguide wall.

15 Such a transition from a waveguide to a microstrip is known from US 5,202,648. In this connection, the microstrip extends on the upper side of the substrate and the associated ground line consists of a conductive surface on the opposite substrate side which contacts the waveguide wall. One weak point of transitions between a waveguide and a contact strip designed in this way is a reflection attenuation which is frequently too low
20 and also a transmission attenuation which is too high.

It is the underlying object of the invention to provide a transition of the kind first mentioned which has the highest possible reflection attenuation and the lowest possible transmission attenuation.

25

Advantages of the Invention

In accordance with claim 1, the ground line associated with the microstrip consists of a plurality of ground surfaces superimposed on one another which all contact one another by means of through contacts in the substrate. The multi-layer ground line produces a more favorable field
5 conversion from the microstrip to the waveguide, whereby a high reflection attenuation and a low transmission attenuation arises for the transition.

Advantageous further developments of the invention can be seen from the dependent claims.

10

Since a throughplating is provided in the substrate at the end of the microstrip acting as an antenna and projecting into the waveguide, the transition bandwidth becomes larger.

15 To be able to make a good contact between the ground line and the waveguide wall, it is expedient for ground surfaces to be applied to the substrate at both sides next to the microstrip and for these ground surfaces to be in contact with the other ground surfaces superimposed on one another in the substrate via through contacts (vias). Advantageously,
20 the substrate is fixed by at least one screw on a support on the waveguide wall, with the screw being guided through the ground surface and an electrical contact being made between these and the support.

A low transmission attenuation is achieved in that the at least one screw
25 lies with its head on one of the ground surfaces applied to the upper substrate side at the side next to the microstrip and in that a conductive ribbon, which is connected to the waveguide wall, is clamped between the screw head and the ground surface. Alternatively to this, at least one

- 3 -

conductive elastic body can be inserted between one of the two ground surfaces located to the side of the microstrip and a projection of the waveguide wall projecting over the ground surfaces. Moreover, a conductive elastic body can be pressed in between the head of the at least one screw and the projection of the waveguide wall.

Drawing

10 The invention will be described in more detail in the following with reference to a plurality of embodiments shown in the drawing. There are shown:

Figure 1 a perspective illustration of a transition from a waveguide to a microstrip;

Figure 2 a longitudinal section A-A through the transition; and

Figure 3 a cross-section B-B through the transition.

20 Description of embodiments

As can be seen from the perspective schematic diagram in Figure 1, a microstrip 2 extends on a multi-layer substrate 1. An opening 4 is located in a side wall of a waveguide 3 and a tongue 5 located at the substrate projects through it into the waveguide 3. The end of the waveguide 2 extending on the tongue 5 acts as an antenna 6 for coupling the waveguide field to the microstrip and/or vice versa.

As shown in more detail in Figures 2 and 3, two ground surfaces 7 and 8 are applied to the upper substrate side next to the microstrip 2 and, in addition, a plurality of ground surfaces are superimposed on one another within the multi-layer substrate and all have the same ground potential.

- 5 The cross-section B-B through the waveguide 3 into the substrate 1 shown in Figure 3 shows the multi-layer ground surfaces 9 within the substrate 1.

10 The longitudinal section A-A shown in Figure 2 shows the two symmetrical ground surfaces 7 and 8 at both sides of the microstrip 2. These ground surfaces 7 and 8 on the upper substrate side are connected in an electrically conductive manner by a plurality of through contacts 10 to the other ground surfaces 9 superimposed on one another within the substrate 1. The positions and spacings of the through contacts 10 are
15 selected such that a field propagation into the intermediate areas between the ground surfaces of the multi-layer substrate 1 is prevented, since the function of circuits arranged in the individual substrate layers could thereby be interfered with.

- 20 The ground surfaces 9 of the substrate 1 preferably project some tenths of a millimeter into the waveguide 3 in order to increase the positional tolerance of the substrate 1 with respect to the waveguide 3. The field configuration beneath the microstrip 2 in the waveguide 3 closely depends on the position of the ground surfaces 9. If the position of the substrate 1
25 is now slightly changed, then the field remains unchanged due to the positional tolerance of the ground surfaces 9. At an operational frequency of, for example, 10 GHz, a penetration depth of the ground surfaces 9 into the waveguide 3 of 0.5 – 1.0 mm is appropriate.

The multi-layer substrate 1 forms a larger virtual ground, whereby a field configuration arises which is better transformed into a waveguide wave. The field is namely shaped more intensely into a field component of the fundamental wave type of the waveguide by the larger expansion of the ground (due to the many ground surfaces stacked on top of one another) in the direction of the broad side of the waveguide 3.

It can be seen from Figures 2 and 3 that a throughplating 11 is provided at the end of the antenna 6 of the microstrip 2 extending on the substrate tongue 5. This throughplating 11 at the end of the antenna 6 of the microstrip results in a broadening of the frequency band of the transition from the waveguide 3 to the microstrip 2. The through contact 11 at the end of the antenna 6 also becomes larger due to the thicker design of the substrate 1, which contributes to a more favorable conversion of the microstrip field into the waveguide field.

The substrate 1 is fixed to a support 14 beneath the opening 14 and starting from the waveguide wall by means of at least one screw - there are two screws 12 and 13 in the embodiment shown in Figure 2. In this connection, the screws 12 and 13 lie with their heads on the ground surfaces 7 and 8 applied to the side next to the microstrip 2 and thus make an electrical contact between the ground surfaces 7 and 8 and the ground surfaces 9 superimposed on one another in the substrate 1 and the waveguide wall 14. Since a contact is additionally made between the ground lines 7 and 8 applied to the upper side of the substrate 1 and the waveguide wall, the transmission attenuation of the transition is reduced. This contact can, as shown in Figure 2, be made by two conductive

ribbons 15 and 16 which are clamped at one end between the heads of the screws 12 and 13 and the conductive surfaces 7 and 8 and at their other end in the parting plane 17 of the waveguide 3 consisting of two half shells.

5

Figure 3 shows another variant for the contact of the ground surfaces 7, 8 and screws 12, 13 with the waveguide wall. Here, the waveguide 3 has a wall projection 18 above its opening 4 which projects over the ground surfaces 7 and 8 on the upper side of the substrate 1. One ore more

10 conductive elastic bodies 19 are clamped between the ground surfaces 7 and 8 on the upper substrate side and the wall projection 18. One or more conductive elastic bodies 20 can also be pressed between the heads of the screws 12 and 13 and the wall projection 18.

5 Claims

1. A transition from a waveguide to a microstrip, wherein the microstrip (2) extending on a substrate (1) projects through an opening (4) into the waveguide (3) and a ground line (7, 8, 9) belonging to the microstrip (2) has contact with the waveguide wall, characterized in that the ground line consists of a plurality of ground surfaces (7, 8, 9) superimposed on one another in the substrate (2) which all contact one another by means of through contacts in the substrate (2).
2. A transition in accordance with claim 1, characterized in that a throughplating (11) is provided in the substrate (2, 5) at the end of the microstrip (2) projecting into the waveguide (3) and acting as an antenna (6).
3. A transition in accordance with claim 1, characterized in that ground surfaces (7, 8) are applied to the substrate (1) at both sides next to the microstrip (2), and in that these ground surfaces (7, 8) come into contact with the other ground surfaces (9) superimposed on one another in the substrate (1) via through contacts (10).
4. A transition in accordance with claim 1, characterized in that the substrate (1) is fixed on a support (14) at the waveguide wall by at

least one screw (12, 13), and in that the screw (12, 13) is guided through the ground surfaces (7, 8, 9) and makes an electrical contact between these and the support (14).

5 5. A transition in accordance with claims 3 and 4, characterized in that the at least one screw (12, 13) lies with its head on one of the ground surfaces (7, 8) applied to the upper substrate side to the side next to the microstrip (2), and in that a conductive ribbon (15, 16), which is connected to the waveguide wall, is clamped between
10 the screw head and the ground surface (7, 8).

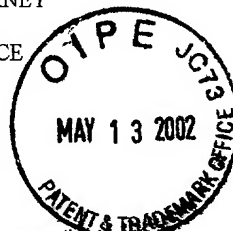
6. A transition in accordance with claim 3, characterized in that at least one conductive elastic body (19) is inserted between at least one ground surface (7, 8) located at both sides of the microstrip (2)
15 on the upper substrate side and a projection (18) of the waveguide wall projecting beyond this ground surface (7, 8).

7. A transition in accordance with claims 4 and 6, characterized in that a conductive elastic body (20) is inserted between the head of
20 the at least one screw (12, 13) and the projection (18) of the waveguide wall.

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name:

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention described and claimed in international application No. PCT/IB00/01140 entitled: TRANSITION FROM A WAVEGUIDE TO A MICROSTRIP and as amended on _____ (if any), which I have reviewed, and I understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and for which I solicit a patent; that I do not know and do not believe that this invention was ever known or used in the United States of America before my or our invention or discovery thereof, or patented or described in any printed publication in any country before my or our invention or discovery thereof, or more than one year prior to my international application; that this invention was not in public use or on sale in the United States of America for more than one year prior to my international application; that this invention has not been patented or made the subject of an inventor's certificate issued before the date of my international application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months before my international application; that I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application; and that prior to filing said international application, applications for patent or inventor's certificate on this invention of discovery which have been filed by me or my legal representatives or assigns in any country foreign to the United States of America are as follows:

(a) none filed more than 12 months prior to said international application, unless named below:

(b) earliest filed less than 12 months prior to said international application (the priority of which is hereby claimed under 35 U.S.C. Section 365):

DE 199 34 351.9 filed July 22, 1999.

I hereby claim the benefit under Title 35, United States Code, §120, of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a), which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.)

(Filing Date)

(Status)(patented, pending, abandoned)

I hereby appoint Todd T. Taylor, Reg. No. 36,945; Ronald K. Aust, Reg. No. 36,735; Keith J. Swedo, Reg. No. 43,176 and Jeffrey T. Knapp, Reg. No. 43,384, of the firm of TAYLOR & AUST, P.C., as attorney(s)/patent agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

SEND CORRESPONDENCE TO:
Todd T. Taylor
TAYLOR & AUST, P.C.
142 S. Main Street
P.O. Box 560
Avilla, IN 46710

DIRECT TELEPHONE CALLS TO:
Todd T. Taylor
Telephone: 219-897-3400
FAX: 219-897-9300

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Sigmund Lenz

Residence: Aspach, Federal Republic of Germany

Citizenship: DE

Post Office Address: Im Muehlfeld 9, 71546 Aspach, Federal Republic of Germany

Inventors Signature: [Signature]

Date: 03/28/02

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2-00
Full name of second inventor: Achim StrouhalResidence: Murrhardt, Federal Republic of Germany DEX

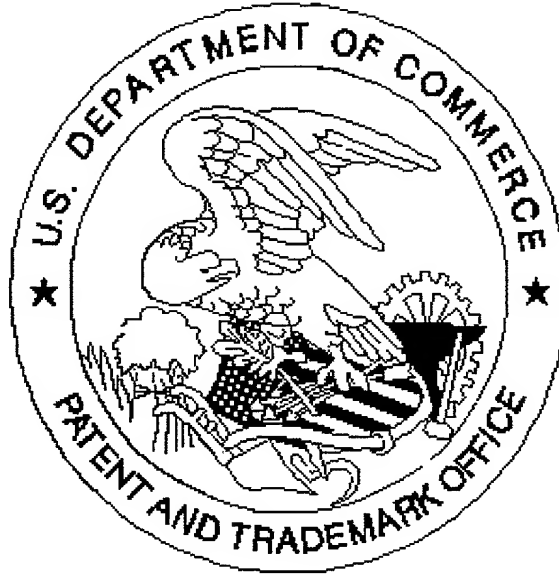
Citizenship: DE

Post Office Address: Holderweg 8, 71540 Murrhardt, Federal Republic of GermanyInventors Signature: A. StrouhalDate: 02.04.20073-00
Full name of third inventor: Siegbert MartinResidence: Oppenweiler, Federal Republic of Germany DEX

Citizenship: DE

Post Office Address: Koenigsbergerstr. 4, 71570 Oppenweiler, Federal Republic of GermanyInventors Signature: S. MartinDate: 28.03.07

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